



CHEMICAL AND TECHNOLOGICAL SYSTEMS

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RESEARCH OF METHODS OF OBTAINING CONTINUOUS FIBRES OF WHISKERS

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The object of this research is some methods of obtaining continuous fibers of whiskers. The method of obtaining such fibers by extrusion of an organometallic colloidal solution is studied using the example of a scheme for carrying out such process. The process of obtaining fibers by the method of pyrolysis of polymeric fibers is studied using the example of another conceptual scheme. The problematic aspects of carrying out both processes and the use of such methods include the difficulty in obtaining the desired configuration and orientation of the fibers of threadlike crystals, as well as the inadequate perfection of the apparatus and installations for obtaining such fibers. When writing the work, various methods of scientific research were used, such as the method of statistical analysis, the method of analyzing the research results, the hypothetico-deductive method and the method of generalizing the results. The conducted studies show that the conditions for carrying out both processes must be strictly controlled, especially the temperature rise. It is shown that the methods used have an increased degree of danger. It is substantiated that, in spite of observance of all parameters of the conducted processes, the fact that the final fibers of the crystals will not have the necessary orientation and configuration may not be ruled out. As a result of the studies it is shown that the production of continuous fibers of whiskers by extrusion of an organometallic colloid solution is quite effective from the point of view of obtaining the final product of the desired orientation and the necessary parameters. The effectiveness of this method can be improved if the processes of doping the fibers from the gas phase are successfully used. It is shown that when carrying out studies of obtaining similar fibers by pyrolysis, it is possible to have high efficiency of the completed process, with full observance of the parameters of its conduct and sufficient perfection of the equipment. A fairly significant issue when using this particular method is the most effective conduct of the tension process of continuous fibers of whiskers during the heat treatment.

Keywords: methods of obtaining whiskers, continuous fibers, organometallic solution.

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ANALYSIS OF METHODS OF REGULATION OF SILICON DIOXIDE PARTICLES SIZE OBTAINED BY THE STOBER METHOD

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The object of research is the method of synthesis of silicon dioxide nanoparticles, namely the Stober method. Synthesis of particles with the help of the Stober process is an example of a sol-gel method, one of the most practical and controlled methods for obtaining controlled size nanoparticles, shapes and morphologies. The Stober method is a classical approach to the synthesis of silica nanoparticles, but in existing works there is no systematic approach to establishing a connection between such reaction parameters as the concentration of components, temperature and time of the process. During the research, various types of information retrieval and information research were used. As a result of this work, a survey is obtained that is able to solve the problem of systematizing the influence of these parameters under the conditions of the Stober process. Methods for regulating the size of silica particles are considered, namely, a change in: a temperature in a sufficiently wide range from 5 °C to 65 °C; TEOS/H₂O/NH₃ concentration; quantity and thermodynamic quality of the solvent, as well as the effect of the reaction time. The influence of these parameters is considered not only from the point of view of changing the unit parameter, but also in combination with the others. The regularities of the particle diameter variation for the main synthesis conditions are established. The ways of particle synthesis by the Stober method from hundreds of nanometers to micrometers are shown. It is shown that for the synthesis of particles with minimal dimensions, a decrease in the concentration of the reacting components will be necessary: TEOS, H₂O and NH₃. This makes it possible to reduce the rate of hydrolysis and condensation processes, as well as the solubility of the intermediate Si(OC₂H₅)_{4-x}(OH)_x, which determines the absence of supersaturation during nucleation. The determining factors for this decrease are the increased synthesis temperature and the use of more polar solvents. The results of the work can be used to control the synthesis of silicon dioxide nanoparticles for various applications, from catalytic systems to functional fillers of materials and in particular to the creation of superhydrophobic structures.

Keywords: Stober method, silicon dioxide doped nanoparticles, nanoparticle size regulation, sol-gel process.

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DEVELOPMENT OF SOFTWARE FOR ANALYSIS AND OPTIMIZATION OF OPERATING MODES OF UNDERGROUND GAS STORES

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The object of research is underground gas storage facilities (UGS) and their technological facilities that are involved in the processes of gas injection, storage and extraction. One of the most important identified problems is the provision of reliable and economical operation of UGS in the gas transportation system (GTS) of Ukraine. One of the ways to solve the problem is development of effective software as decision-making tools, which, in the course of the studies, are not available in the dispatching services for managing the GTS.

The analysis of existing programs on the market of software products shows their inconsistency with the necessary requirements for functionality, set and speed of solving problems. Basically, the developed software is oriented to the exploitation of coal-mining enterprises and could not be adapted for the operation of UGS facilities, where processes, especially filtration in reservoirs, are much faster.

The development of a new multifunctional software product is aimed at providing modeling processes for gas dynamic and filtration processes in UGS facilities, identifying their technical and technological status and planning operational parameters of UGS facilities.

The developed software product provides clarification of geophysical parameters of the reservoirs of the most UGS GTS reservoirs. The obtained estimates of the magnitude of the effect from the UGS reconstruction in cases of physico-chemical cuts of wells, the replacement of compressor stations of gas compressor units with imported ones with the best efficiency, in the transition from flow line-collector system of gas collection to fully flow lines. The developed software is also used for high-precision simulation of operating modes in extreme conditions of UGS operation.

The systemic effect of the operation of the developed software is achieved by conducting studies to form pre-project solutions. As

well as numerical experiments to study and evaluate the optimization potential, and to optimize the planning of promising solutions and operational operation.

Keywords: software, underground gas storage, gas filtration, operational planning, compressor station.

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GENERALIZATION OF THE AERODYNAMIC CHARACTERISTICS OF THE CYCLONE AND VORTEX CHAMBERS DURING THEIR FUNCTIONING

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The object of research is cyclone and vortex chambers. Dust collectors in the form of cyclones and vortex chambers are promising for studying the process and improving their designs. One of the most problematic areas is the purification of aerodisperse systems, high hydraulic resistance, complex operation and installation, the need for powerful blowing devices.

The methods used to clean aerodisperse systems from dust, fog and harmful impurities, and the required purification efficiency are determined by sanitary and technological requirements. They also depend on the physicochemical properties of the impurities themselves, on the composition and activity of the reagents, and on the design of the devices used for purification. In connection with this, various technologies and methods of purification are used.

During the research:

- analysis of the state of the theoretical description of the processes of «dry» purification of aerodisperse systems and known structures is performed;

- analysis of methods for calculating the degree of gas purification from dust;

- it is proved that modern methods of calculation don't take into account some parameters, namely:

- a) the characteristic structure of the swirling flow;

- b) extinction of the swirling intensity as the flow is removed from the swirler;

- c) changes in gas density in the radial direction under the action of centrifugal mass forces;

- d) changes in the distribution of dispersed particles in size after passage of the air-dispersed system of swirlers;

- it is suggested to consider in the calculations and studies the dust purification device as a complex;

- it is proved that the proposed design most fully reflects the features of the process of «dry» purification of the dust and gas flow;

- an equation is obtained which allows to estimate the tangential component of the rotation velocity of aerodisperse systems in a cyclone;

- it is proved that the tangential component of the rotation velocity of the aerodisperse systems in the vortex apparatus varies depending on the intensity of the vortex and its attenuation.

Due to the study of flow dynamics, it is possible to increase the degree of flow purification, to improve the design of the dust purification equipment.

Keywords: aerodisperse flow, vortex chamber, cyclone apparatus, dust purification methods.

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ANALYSIS OF RECYCLING OF NON-FERROUS METALS AS A PART OF RECYCLING OF SEA-GOING SHIPS

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The object of research is the processes of recycling non-ferrous metals in the recycling of sea-going ships. Recycling is the main direction for development of non-ferrous metallurgy. As the world experience shows, the use of secondary raw materials is more economically effective and environmentally safer than the use of primary resources. One of the most problematic places is the lack of recycling and modern environmental recycling technologies in Ukraine. In the study, the analysis method was used to study the dynamics of copper production in the world and the method of classification when considering the properties, the use of non-ferrous metals in shipbuilding, and also when identifying potential consumers of non-ferrous metals.

In paper the analysis of properties of non-ferrous metals used in ship-building is carried out, their application in a ship design is shown. The analysis of enterprises of Ukraine, which are the main potential consumers of non-ferrous metals, as recyclables, is carried out. The largest non-ferrous metal processing plant in Ukraine – OJSC «Non-Ferrous Metals Processing Plant» (Bakmut) – uses only non-ferrous scrap as its raw material. The rationale for the role of secondary scrap in the development of the production of non-ferrous metals in Ukraine is obtained. The dynamics of copper production in the world is analyzed. It is emphasized that the methodology used in Ukraine for assessing the benefits of different recycling classes is obsolete and does not allow correctly calculating the revenue and expenditure parts and assessing the risks. Due to the changes in the integrated approach in assessing the economic efficiency of the use of new technologies in production, the adoption of the state program for the recycling of sea-going ships can provide an increase in annual profits, the period of recoupment of costs, profitability, and the percentage of non-ferrous metal recycling.

Keywords: non-ferrous metals recycling, sea-going ship recycling, secondary raw materials for metallurgy.

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EFFICIENCY ESTIMATION OF CATION-EXCHANGE RECOVERY OF HEAVY METALS FROM SOLUTIONS CONTAINING THEIR MIXTURES

page 41–47

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The object of research is the washing waste water of galvanic plants containing heavy metal cations. The most common reagent methods for purification of galvanic drains do not provide the required degree of water purification, are accompanied by the loss of valuable components and the formation of significant amounts of toxic sludge. Ion exchange is promising in development of wastewater treatment of galvanic productions.

One of the most important problems of ion-exchange technology is the processes of regeneration of ion exchangers, and, in particular, the recycling of spent regeneration solutions. The most promising in the recovery of regeneration solutions is the electrochemical method. However, electroextraction of zinc and nickel is practically impossible from acidic solutions without separation of the electrode space by the membrane. In addition, effluents from the galvanic industry contain mixtures of heavy metal ions. This complicates the process of wastewater treatment and the return of valuable components to production.

In the course of the study, a strongly acidic cation exchanger KU-2-8 in the Na⁺-form is used to study the processes of combined sorption of heavy metal ions. Regeneration of the cation exchanger is carried out with solutions of sulfuric and hydrochloric acids. Electroextraction of zinc and nickel from acid regeneration solutions is carried out in a two-cell electrolyzer with an anion-exchange membrane MA-41.

The obtained results indicate that under conditions of the concentration of heavy metals on cation exchanger KU-2-8, efficient separation can't be achieved. It is established that ions of heavy metals are sorbed individually and in mixtures with other ions of heavy metals are effectively desorbed by solutions of sulfuric and hydrochloric acids.

The use of a two-cell electrolyzer, in contrast to carrying out electrolysis processes without separation of the electrode space, almost completely eliminates zinc and nickel ions from acidic regenerative rods. And to obtain a solution of sulfuric acid in the anode chamber at a concentration of 239–651 meq/dm³.

Keywords: wastewater treatment; electroextraction of cations of heavy metals; ion exchange method.

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THE SOLVENT SUBLATION OF BROMOCRESOL GREEN FROM WATERS SOLUTIONS

page 48–53

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The object of research is wastewaters contaminated with dyes. The available methods for treating wastewater from dyes are often imperfect, ineffective or absent. This calls for the development and implementation of efficient and inexpensive to use and operate dye removal technologies. When treating wastewater, the biggest problem is removing the dyes from dilute low-concentration solutions. For the purification of such effluents, solvent sublation is suggested. This method is based on a combination of flotation and extraction techniques, and on the transmission of gas bubbles through the aqueous phase and removal of the pollutant (sublate) into the organic phase.

During the study, imitates of contaminated wastewater with an anionic dye bromocresol green are used in the concentration range of 2–20 mg/dm³. The influence of some parameters on the dye removal degree is studied: the pH of the initial solution, the molar ratio surfactant: dye, the size of the air bubbles, the initial concentration of the dye, and the solvent sublation duration. The rational conditions for removing the dye are established: pH 3–3.5, molar ratio bromocresol green-hexadecylpyridinium chloride=1:1. Effective removal of the dye is ensured by using a Schott filter with a pore diameter of 100 μm, an air flow rate of 110–120 cm³/min, duration –10 min. Under these conditions, the dye removal degree is 88–99 %.

The obtained results confirm the prospects of the proposed method for the effective removal of dyes from low-concentration aqueous solutions. The method has several advantages:

- possibility to work with large volumes of water bodies;
- active substance is carried out by gas bubbles and enters the hydrophobic liquid layer without mixing the phases;
- process is not equilibrium and is not limited by the distribution constant;
- impossibility of formation of emulsions;
- multiple concentration of ions in small volumes of organic solvent;
- requires a small amount of extractant compared to liquid extraction.

Keywords: solvent sublation of dyes, surfactants, sewage, bromocresol green, hexadecylpyridinium chloride.

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FOOD PRODUCTION TECHNOLOGY

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RESEARCH OF FLAVOUR CHARACTERISTICS OF BEER WITH ADDITION OF PINE EXTRACT

page 54–60

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The object of research is a light beer made according to the classical recipe (control) and beer «Emerald», made according to the classical recipe with the addition of pine extract. One of the most problematic places is that the expansion of the assortment of craft beer leads to the emergence of products with the addition of numerous synthetic components and flavors. The tasting method for evaluating the beverage is rather subjective, since it can't fully characterize the effect of the qualitative composition and the quantitative content of the components of the raw materials used. Therefore, it is important to pay attention to the determination of the total amount of substances that are formed during the fermentation of beer wort and form the natural taste and aroma of the finished product.

To carry out the experimental studies, malt barley light, hop granules, brewer's yeast of bottom fermentation were used as the main raw material. Additional raw materials are selected pine needles. As methods of research, the method of high-performance gas chromatography and an adapted method for determining the number of fragrance are used.

The concentration of flavoring substances is determined: beer control has 32 components, «Emerald» – 38, their calculations are carried out. It is determined that by-products of alcoholic fermentation refer to the factors that determine the taste and aroma of beer.

To fully assess the weight of the aroma of the developed beer, the total content of the substances responsible for the flavor of the beverage is determined. It is found that the beer «Emerald» has a flavor number of 2740 ml of Na₂S₂O₃/100 ml, control – 2170 ml of Na₂S₂O₃/100 ml. This fully characterizes the effect on the finished product of the quantitative content of aroma-making additional raw materials.

The positive effect of the developed beer «Emerald» is achieved due to: natural components, improved organoleptic parameters of the finished beverage, consumer's curiosity to the new product. Also, the high antioxidant properties of additional raw materials contribute to reducing the negative impact of alcohol on the human body. Due to the partial replacement of hops, a lower price for the product was obtained in comparison with the analog product and a decrease in the negative influence of hop on the human body.

Keywords: beer with addition of pine extract, hop replacement, flavoring substances, aroma number, aroma and taste of beer.

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DEVELOPMENT OF THE MEASUREMENT METHOD OF POROSITY OF BAKERY PRODUCTS BY ANALYSIS OF DIGITAL IMAGE

page 61–66

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Bakery products are an integral part of nutrition, so measuring their quality forms the conditions for a more stable operation of the enterprise. One of these indicators is porosity, which determines the structure of the product, volume, level of digestibility. The size of the pores of bread depends on the grade of flour used or their mixture, the level of good practice in carrying out technological processes. The object of the study is a method for measuring the porosity of bakery products based on research of digital images of slices of bakery products.

The use of the method of the digitization of product sections with the subsequent analysis of the obtained images makes it possible to quickly carry out measurements of porosity. The procedure for determining the porosity is to compare the areas of the pixels of the bread image. The proposed method does not require additional costs and can be implemented using an office scanner. Next to this perspective is the use of this method for measuring the porosity of small-batch bakery products, for which porosity is also a criterion of product quality.

In the course of the studies, the correction factors for the group of products that are made from different types of flour are experimentally established:

- 1.71 – for products of flour of the highest quality;
- 1.44 – for products of wheat flour of the first grade;
- 0.61 – for a mixture of rye and wheat flour.

The determined coefficients that allow to go to the measured value of porosity to the usual value – the one indicated in the normative documentation.

Comparison of the accuracy of the standard method of measuring porosity with the proposed method for analyzing digital images of slices indicates the possibility of using the latter in daily production activities. The proposed method can also be adopted to measure the porosity of small-baked bakery and confectionery flour products for which, in connection with the lack of an effective method, the porosity index is not standardized, although it characterizes the quality of the products.

Keywords: porosity of bakery products, digital image, application of ImageJ program, accuracy of analysis.

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